

**APPLICATION
FOR
UNITED STATES LETTERS PATENT**

APPLICANT NAME: RANDALL J. STUTZMAN, ET AL.
TITLE: FLIP CHIP PACKAGE WITH HEAT SPREADER
ALLOWING MULTIPLE HEAT SINK ATTACHMENT
DOCKET NO. END920030014US1

INTERNATIONAL BUSINESS MACHINES CORPORATION

CERTIFICATE OF MAILING UNDER 37 CFR 1.10	
I hereby certify that, on the date shown below, this correspondence is being deposited with the United States Postal Service in an envelope addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 as "Express Mail Post Office to Addressee"	
Mailing Label No. <u>ER063655565US</u>	
on <u>8/05/03</u>	
Bethany J. Fitzpatrick	
Name of person mailing paper	
<u>Bethany J. Fitzpatrick</u>	<u>8-5-03</u>
Signature	Date

FLIP CHIP PACKAGE WITH HEAT SPREADER ALLOWING MULTIPLE
HEAT SINK ATTACHMENT

Background of the Invention

1. Field of the Invention

5 The present invention relates to an electronic packaging arrangement. More particularly, the present invention relates to an electronic packaging arrangement employing a heat spreader designed to facilitate multiple and reworkable heat sink attachment directly to chip carrier.

2. Background and Related Art

10 As the integrated circuit art moves toward smaller and smaller component sizes leading to increased density of circuits and more and more input/output (I/O) connections, the heat generated by such increased density increases correspondingly. Moreover, with such increased density, the cost of integrated circuit packages, such as flip chip packages, also increases.

15 Thus, efficient cooling and reworkability of such packages is highly desirable. Accordingly, where electronic device failure of the package occurs, efficient heat dissipating structure should be such as to be readily removed in non-destructive manner.

20 Typically, heat sink arrangements employing heat fins are positioned in thermal contact with the integrated circuit package mounted on a printed

circuit board (PCB). The heat sink is, in turn, removably attached to the printed circuit board. An elastomeric thermal pad or thermal grease may be interposed between heat sink and integrated circuit package to compensate for any mismatch in physical characteristics and thermal expansion between heat
5 sink and integrated circuit package, as well as reduce interface resistance. An example of such an arrangement may be found in U.S. Patent No. 6,125,037. One of the difficulties in cooling integrated circuit packages is thermally contacting a sufficiently large heat dissipating surface to the integrated circuit to effectively spread heat generated therefrom. Packaging constraints often
10 limit the area size of the heat dissipating surface, particularly where such packages are designed to be reworkable. Moreover, integrated circuit products, such as, single chip flip chip modules, often employ different cooling arrangements for the same product. For example, flip chips may be employed in a single chip module using some form of clip to hold the heat sink in thermal
15 contact with the chip on the PCB. Alternatively, the heat sink may be attached by screws or posts to the PCB.

Summary of the Present Invention

In accordance with the present invention, a packaging arrangement is provided wherein a heat sink and heat spreading lid are directly attached to the
20 chip carrier. The heat spreading lid is sufficiently large to accommodate effective spreading of heat from the chip and yet is designed to allow heat sink attachment by either posts positioned directly on the chip carrier at its corners,

or by some form of chip arrangement clamped to the underside of the lid or chip carrier at the mid-section of the heat sink.

It is, therefore, an object of the present invention to provide an improved integrated circuit package.

5 It is a further object of the present invention to provide an integrated circuit package with improved cooling.

It is yet a further object of the present invention to provide an improved reworkable flip chip package.

It is yet still a further object of the present invention to provide an
10 improved heat sink attachment arrangement wherein the heat sink is attached directly to the chip carrier.

It is another object of the present invention to provide a removable heat sink and heat spreading lid that provides effective chip cooling, with said heat spreading lid arranged to facilitate heat sink attachment to the chip carrier by
15 posts arranged on the carrier or by clipping to the lid or carrier.

It is yet another object of the present invention to provide a chip module having attachment posts on the chip carrier for attaching a heat sink directly to the chip carrier, and a heat spreading lid interposing the heat sink and chip or chips with the surface area of the lid being approximately the size of the
20 surface area of the chip carrier so as to effectively spread heat, protect the chip(s) and facilitate heat sink attachment by either the attachment posts or a heat sink clip acting to clamp the heat sink to the chip carrier.

These foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a

preferred embodiment of the invention, as illustrated in the accompanying drawings, wherein like reference members represent like parts of the invention.

Brief Description of the Drawing

Figure 1 shows an exploded perspective view of the chip package, in
5 accordance with the present invention.

Figure 2 shows a partially exploded perspective view of the chip package, in accordance with the present invention.

Figure 3 shows a side view of an assembled chip package.

Figure 3A shows a further clip configuration that may be used to hold
10 the heat sink and heat spreading lid on the chip carrier.

Detailed Description

With reference to Figure 1, there is shown an exploded view of the integrated circuit package, in accordance with the present invention. Chip
15 carrier 1 is shown with four retention corner posts 3 mounted thereon. Chip carrier 1 may be made of any of a variety of chip carrier materials, such as a laminate chip carrier material.

Corner retention posts 3 may be made of any of a variety of materials such as, metal or plastic, although metal would be more effective in aiding heat
20 dissipation. The post may be affixed to chip carrier 1 by glue or an epoxy adhesive. If the posts are metallized, they may be attached by soldering, welding or the like. In this regard, using an epoxy, solder, or the like, avoids

the necessity of having to modify the chip carrier by forming holes in the carrier for screws, post insertion, or the like. In addition, attaching the posts directly to the chip carrier also avoids the necessity of having to modify the PCB, upon which the chip carrier sets, by forming holes for posts or screws to
5 hold the heat sink thereon. Avoiding the necessity of having to form holes in the PCB for attaching the heat sink saves much needed wiring area.

As further shown in Figure 1, chip 7 is mounted in the central portion of laminate chip carrier 1. As is known to those skilled in the art, an array of solder ball connections on the down side of flip chip 7 are attached to a
10 corresponding array of pads on chip carrier 1. The pads, in turn, are connected to metallurgy which extends to an array of pads on the underside of chip carrier 1. The latter are then attached to contact pads on the PCB.

When the arrangement shown in Figure 1 is fully assembled, heat spreading lid 5 is positioned in thermal contact with chip 7. The lid may be in
15 the form of a plate or a cap. Heat spreading lid 5 is made of a high thermal conductivity material, such as, a metal. For example, aluminum, copper or AlSiC may be used. The heat spreading lid, in accordance with the present invention, can be formed with a surface area approximately that of the chip carrier. In this regard, the edges of the heat spreading lid may be co-extensive
20 with the edges of the carrier except for cutouts 9 at its four corners and cutouts 11 at the midsection of each side. These cutouts minimally reduce the heat dissipating areas of the lid.

As is clear from Figure 1, cutouts 9 at the four corners of heat spreading lid 5 act to accommodate each of the four posts 3, used for attachment of the
25 lid and sink to chip carrier 1. Cutouts or notches 11 at the mid-section of each

side of heat spreading lid 5 act to accommodate attachment of the heat sink and lid to chip carrier 1 using a clip or spring, as shown more specifically in Figure 2. Although the thickness of the lid can be optimized for heat spreading and height requirements, a typical flip chip arrangement would operate
5 effectively with a lid thickness in the range of 0.5mm to 4mm. In this regard, it should be noted that the relative sizes of the various parts shown in Figures 1 - 3A are not to scale, nor scaled proportionately, but are merely shown to facilitate an understanding of the invention.

Heat spreading lid 5 not only acts to effectively dissipate heat from chip
10 7, it also acts to protect the chip, and its design acts to accommodate different modes of heat sink attachment. Lid 5 is attached to chip 7 using a thermally conductive epoxy, which epoxy allows for effective heat dissipation and provides sufficient compliance for any mismatch in physical and thermal expansion characteristics between lid-heat sink and chip.

15 Heat sink 13, comprising plate 14 and heat dissipating elements 16, may be attached to chip carrier 1 by positioning posts 3 in holes 15 and clamping in place with nuts 17, with lid 5 interposed between plate 14 and chip carrier. Alternatively, heat sink 13 may also be attached to chip carrier 1 by positioning posts 3 in holes 15 and clamping in place with a clip arranged to fit
20 into notch 11 in heat spreading lid 5 and notch 19 in heat sink 13 and then extend to the underside of lid 5. Alternatively, the clip may be designed to extend beyond the lid to clamp the heat sink to the underside of chip carrier 1.

Since corner posts 3 provide structural support, any of a variety of thermally conductive materials, such as a thermally conductive grease, may be
25 used between heat spreading lid 5 and heat sink 13 to enhance thermal

performance. This allows for easy removal of the heat sink for rework.

However, it is also possible to use a thermally conductive adhesive between lid 5 and heat sink 13 and, in such case, the use of nuts or a clamp to hold the heat sink in place may not be necessary.

5 With reference to Figure 2, there is shown a partially exploded perspective view of the view of Figure 1, showing a clip arrangement that may be used to clamp the heat sink and lid to chip carrier. Thus, when heat sink 13 is positioned on heat spreading lid 5 so that posts 3 extend up through holes 15 in the heat sink, clip 21 may be positioned to engage both notches 19 in the
10 heat sink and notches 11 in lid 5, and then may expanded by force to clear chip carrier 1 so that, upon release of the force, holding segments 23 of the clip act to engage the underside of the chip carrier, locking the heat sink and lid to the chip carrier. Alternatively, where lid 5 is securely attached to chip 7 with thermally conductive adhesive, for example, the clip may be designed so that
15 upon release of the expanding force, holding segments 23 of the clip act to engage the underside of the lid. It is noted that heat spreading lid 5 has notches on all four sides so that it may be positioned, without regard to orientation, for alignment to notch 19. As can be seen, for maximum heat spreading capability, heat spreading lid 15 is made to extend to the edges of
20 chip carrier 1.

 Figure 3 shows an end view of the assembled package 25 with like reference characters identifying like elements of Figures 1 and 2. As in Figures 1 and 2, heat spreading lid 5 is attached to flip chip 7 by a thermally conductive epoxy leaving a gap around the chip between lid and chip carrier 1.
25 Alternatively, the gap may be filled with thermally conductive epoxy 18 or

other like material. Similar to Figure 2, the assembled package of Figure 3 uses a clip to attach heat sink 13 and lid 5 to chip carrier 1. The design structure of clip 27 is, however, different than the structure of clip 21 of Figure 2. Although clip 27 is shown in Figure 3 extending to clamp to the underside of chip carrier 1, as previously described with respect to Figures 1 and 2, the clip may also be arranged to extend and clamp to the underside of lid 5.

Clip 27 in Figure 3A is designed so that the bowed midpoint 29 of its lateral element 31 contacts surface 33 of heat sink 13. Clip 27 is engaged by sliding clip holding segments 35 and clip leg segments 37 into respective notches 19 and 11 of the heat sink and lid at opposing edges, and then pressing downwardly so holding segments 35 slide over the edges of chip carrier 1, thereby spreading the clip. After passing over the edges of the chip carrier, the clip returns to its relaxed position whereby holding segments 35 engage the underside of chip carrier 1, thereby clamping the heat sink and lid to the carrier. Alternatively, rather than pressing downwardly to the point of engaging the underside of chip carrier 1, the clip may be pressed to the point of allowing holding segments 35 to slide over and engage the underside of lid 5.

As is understood by those skilled in the art, any of a variety of flexible resilient materials having a high spring rate may be employed to fabricate the clips. In this regard, it is clear that the clip must have the ability to return to its original form, i.e., relaxed state, after being forced out of shape. For example, clips 21 and 27 may be formed from hard type stainless steel or, more generally steel, although other materials such as beryllium copper may be used. Typically, clips 21 and 27 would be integral, i.e., formed from a single piece and are fabricated using well known techniques such as stamping and bending

a single piece of metal. The clips may be wire shape or ribbon shape. Also, as is understood by those skilled in the art, the dimensions of the clips must be tailored to the dimensions of the combined heat sink, lid, chip and chip carrier and designed to provide adequate clamping force. It is clear, that other
5 structural design configurations may as well be employed to fabricate a clip to fit over the heat sink and lid in the notches provided therefor to thereby clamp same to the chip carrier.

Rather than employ a clip to attach heat sink 13 to chip carrier 1, nuts may be used on threaded post 3 to hold the assembly together. In this regard,
10 the posts may be designed to have a slightly larger circumference at its base to facilitate good mechanical attachment to the chip carrier.

Regardless of whether the method of attachment is through a clip, attached nuts or adhesive, heat spreading lid 5, as designed, may be used. Thus, a single configuration of heat spreading lid may be used for each method
15 of heat sink attachment. It is clear that the heat spreading lid may also be attached by the above methods without the heat sink. Such an arrangement may be employed where the lid would provide sufficient heat dissipation.

Direct attachment of the heat sink and lid to the chip carrier provides a number of advantages. The resultant package provides a removable heat sink
20 for rework which is capable of assembly without modification to the circuit board upon which it is to be mounted. In this regard, the owner of the circuit board may be the customer while the chip package may be provided by the supplier, and attaching the heat sink to the chip carrier rather than PCB simplifies the process, and reduces the cost and complexity of assembly. In
25 addition, attachment of the heat sink may be undertaken either before or after

mounting on the PCB. Moreover, rework to remove the heat sink, lid and chip after mounting is simplified. Since a single heat spreading lid configuration acts to facilitate different modes of heat sink attachment, the mode of heat sink attachment may be changed upon rework.

5 Although description of the chip package, in accordance with the present invention, has been directed to a single chip, it is clear that more than one chip may be attached to chip carrier 1. Attachment of the chip to the chip carrier may be through a flip chip interconnection by solder balls, or may be by solder or pins, or the like.

10 It should be understood that the chip package, in accordance with the present invention, is designed to be further attached to some form of substrate, such as, a PCB. Accordingly, although not shown in the chip package of Figure 3, the underside surface of chip carrier 1, i.e. the side opposing the chip-mounted side, contains an array of contact pads for connection to a PCB,
15 for example. Such pads may be connected to pads on a PCB by solder, solder balls, pins, or the like.

 It will be understood from the foregoing description that various modifications and changes may be made in the preferred embodiment of the present invention without departing from its true spirit. It is intended that this
20 description is for purposes of illustration only and should not be construed in a limiting sense. The scope of this invention should be limited only by the language of the following claims.

 What is claimed is: